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Accelerator Systems Division

Vacuum Standards Handbook

DRAFT

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SPALLATION NEUTRON SOURCE
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Argonne National Laboratory • Brookhaven National Laboratory • Thomas Jefferson National Accelerator Facility • Lawrence Berkeley National Laboratory • Los Alamos National Laboratory • Oak Ridge National Laboratory
SNS

ACCELERATOR SYSTEMS DIVISION VACUUM STANDARDS HANDBOOK

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1.0 Scope

This Handbook provides guidelines, and imposes requirements where necessary, for the definition of equipment and processes associated with the vacuum systems in the Spallation Neutron Source (SNS) Accelerator Systems Division (ASD). As such, this handbook is applicable only to vacuum components and systems.

This Handbook is intended to ensure consistent standards are employed throughout all the accelerator system vacuum hardware and is not intended to be a textbook on vacuum design.

This Handbook will be continually updated throughout the life of the SNS project. Queries or additional information concerning the contents of this Handbook should be addressed to the SNS Vacuum Group Leader.

2.0 Vacuum Requirements

The successful operation of SNS is dependent upon the reliable operation of the accelerator vacuum system in the high and ultra-high vacuum range during operating conditions.

The required vacuum level varies over the different accelerator subsystems, i.e. the Front End, Warm Linac, Superconducting Linac, and Ring. The operational vacuum pressure level requirements have been analytically determined[1] and are provided in the SNS Parameters List[2]. These levels are summarized as follows:

Front End	TBD to 4x10^{-7} Torr
Drift Tube Linac	2x10^{-7} Torr
Coupled Cavity Linac	5x10^{-8} Torr
Superconducting Linac	1x10^{-9} Torr
HEBT	5x10^{-8} to 1x10^{-9} Torr
Ring	1x10^{-9} Torr
RTBT	5x10^{-9} to 1x10^{-7} Torr

Associated with the vacuum pressure levels are the availability and reliability requirements of the vacuum subsystems and their components.

The subsystems' design basis shall have a performance margin of 2, i.e. the failure of any single pumping element may degrade the subsystem pressure level, but will not reduce it below the above listed levels where the accelerator operation is compromised or terminated.

[1] R.E. Shafer, "Beam Loss from H-minus Stripping in the Residual Gas," TN:LANSCE-1:99-085, 5/1/99
[2] "SNS Parameters List," SNS 100000000-PL001-R02, 3/10/00

3.0 Standard Components

The standardization of vacuum components utilized throughout the accelerator is beneficial from multiple perspectives:

- Reduces the number of unique types of components
- Reduces the number of spare unique types which must be maintained
- Reduces the degree of training associated with servicing multiple unique types
- Reduces the number of unique specific locations and required interfaces
- Reduces variances in performance and calibration
- Reduces costs by economy of scale and a centralizes procurement

Where practical, standard components shall be used unless extenuating design or operational circumstances exist necessitating customized applications.

Note on interpretation of the text:
In this document, the word 'shall' is used to denote a mandatory requirement, the word 'should' is used to denote a desirable option, and the word 'may' is used to denote permission (neither a requirement nor a desirable option).

3.1 Pumps

The accelerator system contains a variety of pump types and sizes. An attempt to standardize on the type and sizes is the objective. The pumps for the various subsystems shall be procured under common specifications.[3] [4] [5]

3.1.1 Backing

The backing pumps shall be standardized in regards to the fact that all the pumps shall be "**dry**" pumps, meaning oiless bearing configuration, i.e. no oil shall be capable of reaching the evacuating region.

3.1.2 Roughing

The roughing pumps shall be standardized in regards to the fact that all the pumps shall also be "**dry**" pumps, meaning oiless bearing configuration, i.e. no oil shall be capable of reaching the evacuating region.

The roughing pumps shall be incorporated into a "pump down cart" configuration unless located in the accumulator Ring in an area where activation levels create a personnel exposure issue, ALARA.

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[3] "Vacuum Ion Pump Specification," SNS 00000000-000-R00, 00/00/00.
[4] "Vacuum Turbo Pump Cart Specification," SNS 00000000-000-R00, 00/00/00.
[5] "Vacuum Turbo Pump Station Specification," SNS 00000000-000-R00, 00/00/00.

3.1.3 Turbomolecular

The Turbomolecular (turbo) pumps shall be standardized in regards to the fact that all the pumps shall also be "**dry**" pumps, meaning no oil shall be capable of reaching the evacuating region.

All turbo pumps shall be incorporated into either a "pump down cart" or "turbo pump station" configuration.

The turbo pumps shall be capable of operating from a pressure above 10^{-5} pressure in the event of an emergency.

3.1.4 Ionization

The Ionization (ion) pumps shall be standardized in that all the pumps shall have a sputter diode configuration.

The ion pumps shall be mounted directly to the volumes to be evacuated i.e. no isolation valves shall be utilized for these.

3.1.5 Cryogenic

The cryogenic pumps (cryopumps) shall have valves isolating them from the primary accelerator vacuum accommodating individual in-situ regeneration.

The cryopumps' body shall each contain a pressure relief valve set to open at a low-pressure level.

Insure that the cryosystem is charged only with ultra-pure helium - 99.995% or better.

3.2 Valves

The valves employed by the accelerator consist of two principle types, those physically located within the beamline used to isolate the accelerator sections, and those used to isolate components off-axis of the accelerator elements.

An attempt to standardize on the type and sizes is the objective. The valves for the various subsystems shall be procured under common specifications.[6] [7]

3.2.1 Beamline Isolation

The valves positioned within the beamline used for section isolation shall be standardized in regards that they shall have all-metal gate seals.

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[6] "Vacuum Metal Seal Specification," SNS 00000000-000-R00, 00/00/00.
[7] "Vacuum Quick Acting Valve Specification," SNS 00000000-000-R00, 00/00/00.

These valves shall utilize electro-pneumatic actuation. The valves' actuators' solenoids will be 24 VDC for low voltage protection.

The valves shall have a normally closed configuration, i.e. in the event of a power failure the valves will close.

3.2.2 Component Isolation

The valves utilized for component isolation shall be standardized in that they shall utilize a gate configuration for sealing.

The seals on the valves' gate shall utilize elastomer o-rings. The elastomer seal material must be constructed of Viton.

The off-axis valves may have manual or electro-pneumatic actuation. The valve actuator shall be oriented to minimize personnel exposure levels during maintenance.

3.3 Gauges

The gauges used to measure the vacuum levels within the accelerator and control the operation of valves and pumps shall consist of three principle types, thermal conductivity, ionization and partial pressure.

An attempt to standardize on the type and models is the objective. The gauges for the various subsystems shall be procured under common specifications.[8] [9] [10]

All gauges shall be non-particulate generating when operating.

3.3.1 Low Level

The low vacuum levels within the accelerator, 2 to 10^{-4} Torr, shall be measured using a Pirani type thermal conductivity gauge.

The vacuum gauging shall be used for both monitoring and safety interlocks..

3.3.2 High Level

The high vacuum levels within the accelerator, 10^{-3} to 10^{-11} Torr, shall be measured using a Cold Cathode type ionization gauge.

The vacuum gauging shall be used for both monitoring and safety interlocks.

[8] "Vacuum Thermal Conduction Gauge Specification," SNS 00000000-000-R00, 00/00/00.
[9] "Vacuum Ionization Gauge Specification," SNS 00000000-000-R00, 00/00/00.
[10] "Vacuum Partial Pressure Gauge Specification," SNS 00000000-000-R00, 00/00/00.

3.3.3 Partial Pressure

The high and ultra high vacuum levels within the accelerator, 10^{-4} to 10^{-14} Torr, shall also be measured using a partial pressure Residual Gas Analyzer (RGA) type gauge.

The RGA shall be used to characterize the residual gases in the vacuum during conditioning, thus determining the source type such as a water leak or component outgassing.

3.4 Hardware

The variety of hardware applicable to vacuum usage is too expansive to be discussed in detail in this handbook. A few major constituents will be addressed

3.4.1 Flanges

All vacuum flanges shall be constructed of stainless steel. Those flanges subject to elevated radiation and/or temperature levels shall be designed for metal seal application.

All flanges shall consist of two types, bolted and quick disconnect. Bolted flanges shall use the conflat, knife-edge, sealing configuration. Quick disconnect flanges shall use a smooth compression sealing configuration.

Flanges used for roughing "pump down" purposes shall have a 8-inch OD standard ConFlat-type configuration.

Flanges used for main vacuum pumping purposes (Ion, Turbo and Cryopumps) shall have an 8-inch OD standard ConFlat-type configuration.

Flanges used for mounting of Pirani and Cold Cathode Ion Gauge assemblies shall have a 2.75-inch OD standard ConFlat-type configuration.

Flanges used for mounting of RGA probe assemblies shall have a 2.75-inch standard OD ConFlat-type configuration.

3.4.2 Seals

Elastomer seals may be utilized only in areas subject to low radiation levels and moderate temperatures. Elastomer seals shall be constructed of Viton™ and used where the maximum temperature does not exceed 150^{o} C. Polyimide™ shall be used where the temperature exceeds 150^{o} C but does not exceed 200^{o} C.

Metal seals shall be utilized in areas subject to elevated radiation levels and temperatures. Metal seals shall be constructed of Oxygen Free High Conductivity (OFHC™) copper or aluminum.

All seals are single application only. No seal shall be reused after tightening. Seals shall be discarded after use.

3.4.3 Bellows

The bellows utilized in the beamline shall be constructed of Inconel. Bellows used in off-beamline or low radiation locations may be constructed of stainless steel.

The bellows may be constructed using forming or welded construction.

Bellows used in the beamline shall contain a rf shield.

3.4.4 Fasteners

All fasteners shall be constructed of stainless steel. All fasteners shall utilize a plating, preferably silver, on the threads to prevent galling. Anti-seize lubricant shall not be allowed, thus preventing the possibility of vacuum contamination.

All fasteners are single application only. No fastener shall be reused after final tightening. Fasteners shall be discarded after use.

3.4.5 Feedthroughs

Feedthroughs designed for electrical conduction shall not be used for mechanical support, i.e. no weight, torque or shocks shall be applied.

Feedthroughs designed for motion, rotary or linear, shall use bellows for sealing.

3.5 Controls

The control system for the accelerator vacuum system shall consist of a local control system that will operate in both a stand-alone mode or via a network to the global control system (EPICS).

3.5.1 Architecture

The local control system shall be implemented using a programmable logic controller (PLC).

The vacuum components shall be operated in a manual mode via their own controllers.

In the stand-alone mode, the software LabView shall be used to provide the graphical user interface (GUI) for operation of the vacuum systems.

In the network mode, EPICS shall be used to provide the graphical user interface (GUI) for operation of the vacuum systems via the PLC.

The control and operation of the vacuum components shall be accomplished via programmable set points and interlocks.

3.5.2 Elements

A personal computer (PC) running Windows NT 4.0 shall be used to run the PLC configuration.

The Allen-Bradley ControlLogic shall be the standard PLC.

4.0 Standard Practices

4.1 Design

The subsystems' design basis shall have a performance margin of 2, i.e. the failure of any single pumping element may degrade the subsystem pressure level, but will not reduce it below the levels where the accelerator operation is compromised or terminated.

A minimum Safety Factor (SF) equal to 2 based on material yield strength shall be used for mechanical structural integrity.

Precautions shall be taken to avoid trapped volumes in vacuum spaces that could result in virtual leaks and these spaces shall be suitably vented.

During operation or during outages between operating periods there will be requirements to leak test components in-situ. This requirement shall be taken into account during the design phase. Component shall provide for leak test accessibility.

When access to a joint is particularly complex, a secondary vacuum space shall be provided around the primary joint to limit the consequences of a potential leak.

Design Basis Outgassing Rates:

Material	**Outgassing rate Torr-L/sec/cm^2**	
	Pre-conditioning	**Post-conditioning**

Stainless Steel	$1x10^{-10}$	$1x10^{-10}$	
Copper (OFE)	$2.5x10^{-9}$	$1x10^{-10}$	
Viton™ O-ring permeability	TBD	$1.9x10^{-9}$	TBD

4.2 Materials

This Handbook cannot provide a definitive list of suitable materials for every particular application, but it can provide a list of materials with previously acceptable performance in accelerator vacuum environments.

The choice of material can greatly affect the performance of the vacuum and therefore material selection shall be an integral part of the vacuum standardization process.

<u>Recommended materials</u>

The principal factors that need to be considered when selecting a material for use in a vacuum environment are that they:

- be sufficiently impermeable to gases
- have low vapor pressures. The vapor pressure at the highest operating temperature should be at least two orders below the working pressure to avoid metal contamination to the beam
- be able to withstand baking temperatures without losing their mechanical strength or being chemically or physically damaged
- not transmute from an apparently acceptable material to an unacceptable one
- not react adversely with other materials resulting in outgassing

All materials listed below conform to the material standards and specifications approved for SNS vacuum use.

Structural materials
- Stainless steels – types 316, 316L, 316LN, 304, 304L, 304LN
- Molybdenum
- Titanium
- Nickel
- Inconel

Non-ferrous materials
- Copper - OFHC
- Copper alloys (CuCrZr, DS CuAl25)
- Aluminum

Brazing alloys
- CuInSnNi, CuMnSnCe, AlSi, CuMn, TiZr, Cu-Ti)

Special alloys
- Ti-6Al-4V, Inconel 718, Alloy 660, Kovar

Other materials
- Alumina
- Boron Nitride
- Titanium Nitride
- Vacuum grade windows
- Aluminum bronze
- Alumina ceramic (99%)
- Viton elastomer

4.3 Manufacturing

Next to the material a vacuum component is constructed of, the processes utilized in its manufacture have the greatest influence on its vacuum performance as regards to outgassing, leaks, etc. The following discuss some standard manufacturing processes that should be employed in the fabrication of custom vacuum components.

4.3.1 Forming

The forming techniques acceptable for use in the manufacture of accelerator vacuum components are listed as follows:

<u>Technique</u>
Forging
Rolling
Drawing
Extrusion
Casting *

* Use of cast products or bars is **not permitted** in the vacuum volume or as part of a vacuum containment barrier unless the cast products have been subjected to Hot Isostatic Pressing (HIP) densification after casting. Porous products inside the vacuum environment must be baked prior to installation.

Billets used for forging must be Electro-Slag-Remelted (ESR) or Vacuum-Arc-Remelted (VAR).

Use of sintered products or bars is **not permitted** in the vacuum volume or as part of a vacuum containment barrier.

4.3.2 Machining

All cutting fluids, greases etc. used during manufacture shall be capable of being removed entirely by subsequent cleaning operations.

As a general rule any machining or other manufacturing operation affecting an already tested joint shall dictate an additional pressure and leak test of the joint.

Chemical machining is acceptable as long as the work piece can be properly cleaned to remove any unacceptable materials. However, it is not permitted on seal faces.

4.3.3 Joining

The joining methods acceptable for use in the accelerator vacuum components are listed as follows:

<u>Welded joints</u>
Butt-welded joints are preferred to fillet joints or lap joints because they can be inspected for defects. Welds that cannot be inspected are not permitted.

Corner welds and welds that cross should be avoided as they provide a potential outgassing source.

All welds shall be accessible and where possible shall be located on the vacuum side. A procedure for the repair of welds shall be foreseen at the design stage.

The parts to be welded shall be thoroughly cleaned and degreased. Shielding gases shall be used to minimize oxidation.

<u>Brazed joints</u>
Brazing materials that contain silver shall not be permitted for use within an irradiation environment. The silver transmutes to cadmium and affects the vacuum system.

Soft soldering (< 400°C with Sn, Zn, alloys of Pb, Cd) shall not be permitted.

The remelting point of the solder limits the bakeout of vacuum components for degassing.

Diffusion soldering (not melted but heated and diffused in solid phase) is acceptable for vacuum applications.

Brazed joints shall be produced in an inert atmosphere or under vacuum conditions and shall contain no oxides.

The brazing temperature should be kept as low as possible to avoid loss of the braze filler metal alloy constituents by evaporation.

4.3.4 Finishing

The finishing techniques acceptable for use in the manufacture of accelerator vacuum components are listed as follow section. Particular attention shall be given to surface finishes in order to:

- Minimize the outgassing surface area
- Aid cleaning by ensuring that contaminates does not remain on any rough surface or are entrained below the surface
- Avoid potential leak paths where machining marks cross seal faces

The surface finish of seal faces shall be compatible with the requirements of the seals used. Sealing surfaces must be free of radial scratches or dents.

Seal faces shall be suitably protected immediately after final machining to minimize the risk of damage. This protection should only be removed for the purposes of cleaning and inspection, prior to final assembly.

Surfaces that are exposed to vacuum but are not sealing faces, the surface finish should desirably be 32 μ inch. Non-machined surfaces exposed to vacuum must be free of any grits, porosity and rust since this will degrade vacuum performance.

<u>Special surface coating</u>

The important aspects of coating techniques in terms of vacuum compatibility are:

- The deposited coating shall not be porous and shall not create trapped volumes
- The deposition process shall not induce stresses that could make the piece non leak-tight.

<u>Painting</u>

No painting is permitted on vacuum facing surfaces.

Caution shall be exercised in applying paint to non-vacuum facing surfaces as hydrogen degassing at the paint/metal interface may permeate through the metal wall to the vacuum side in thin wall structures.

<u>Marking</u>

Surfaces that are to be exposed to vacuum shall be marked or identified, if required for a particular component, on a surface by scribing with a clean sharp point. Seal faces shall not be used. Chemical etching is an acceptable alternative.

Dyes, marker pens, paints, etc. shall not be used on surfaces which will be exposed to vacuum. Furthermore, their use shall be avoided on other surfaces to eliminate the potential for cross-contamination during subsequent cleaning operations. The use of such coatings may block porosity in material and result in undetectable leaks.

4.4 Cleaning

It is not possible to cover the cleaning processes for every component in this Handbook, thus the guidelines provided [11] are the minimum requirements which should be followed unless otherwise specified for a particular component.

The objective of cleaning is to reduce or virtually eliminate desorption of gases from the surfaces of materials in the vacuum environment. Cleaning must be regarded not only as the removal of visible dirt from the surfaces but also the removal of all contaminants that physically adhere to the surface or are a result of a chemical reaction e.g. oxides.

Cleaning agents of high vapor pressure shall not be used on oxidized or rough walls that would retain them

Cleaning must not be performed using fluorine, chlorine or any other halogen bearing solvent since these are very difficult to remove.

Degreasing

Degreasing is an important stage in many cleaning operations and may be carried out more than once. Degreasing can either be performed in a vapor degreasing plant or by immersion in a soak cleaner, or by a combination of both methods.

Vapor degreasing shall be followed by a water rinse. Vapor degreasing is effective for the removal of most oils and greases, but it may leave traces of water-soluble compounds.

Soak cleaning will remove most oils and greases, and in addition will remove water-soluble contaminants. As with vapor degreasing, soak cleaning shall be followed by washing. The effectiveness of cleaning by using an immersion technique can be greatly increased by ultrasonic agitation.

Degreasing agents containing chemicals that could adversely affect the surface being cleaned shall not be used.

[11] "Vacuum Component Cleaning Specification," SNS 00000000-000-R00, 00/00/00.

Chemical cleaning

Chemical cleaning should be restricted for use in the cleaning of stock materials. Chemical cleaning of assemblies can possibly transport dirt and soil from accessible areas to inaccessible areas.

A pickled finish shall not be used for ultra-high vacuum components. Pickling produces an etched finish that will vary in roughness depending on the material, contact time and temperature. Components that have been pickled shall be passivated to ensure an even oxide layer.

Washing

Preliminary washing should be performed using running water, such as a spray, starting at the top of the component to be cleaned and ensuring that the whole surface is thoroughly wetted. For the first wash down of the component, normal domestic water with detergent followed by washing with demineralized water.

Electropolishing

Electropolishing can be applied to a wide range of materials. The removal of material from the surface of the component may be uneven as a result of variations in the component or cathode geometry. Sharp features, such as knife edges, are very difficult to polish without the loss of detail. Corners and edges become rounded unless they are protected.

Care should be taken when electropolishing seal faces as this can produce a finish which is "too good" for use with some metal seals (e.g. Helicoflex).

Installation

Good cleanliness practice shall be followed during the installation of all vacuum components.

Vacuum components should remain sealed and packaged until the last possible moment. Inert gas blankets on vacuum surfaces should be maintained as long as possible. Installation personnel should be adequately trained and made aware of the importance of cleanliness.

The environment surrounding the immediate installation shall be as clean as is reasonably practicable. In some locations such as the warm section of the Superconducting Linac, a portable clean room may be employed.

Clean Room Practice

This area should be enclosed and have restricted access to prevent accidental contamination from unauthorized entry. The area should have a controlled atmosphere, depending upon the degree of cleanliness required during assembly.

An air lock or anteroom will be required to maintain standards of cleanliness.

All tools (including tool handles) and benches shall be cleaned prior to introduction into the clean area.

Operators shall be dressed appropriately to avoid dust shedding.

Care should be taken to avoid cross-contamination of clean and dirty components. Only cleaned components should be allowed within the clean room. Clean components shall be handled wearing clean, dry, lint-free gloves.

The component, or parts of the component, shall be suitably packaged as soon as possible to avoid unnecessary contamination.

Packaging

Components shall be suitably packaged in order to protect them from damage and contact with contaminants during transit and storage. The packaging shall be performed immediately after acceptance testing and final cleaning at the manufacturer's premises.

Aluminum foil is recommended for the covering of flanges and openings before sealing the component in a non-permeable covering. Where impractical to enclose the component, all apertures shall be adequately sealed to prevent the ingress of contaminants that could adversely affect the vacuum.

The components shall be transported in rigid packing cases or containers that are lined with waterproof material. All joints shall be sealed.

4.5 Inspections & Testing

This section establishes the minimum standard of inspections and testing necessary to prove acceptability of components and systems from a vacuum perspective only.

Inspections at Manufacturer

The inspections in the manufacturing process shall be clearly stated in the appropriate procurement documentation.

The important aspects to be considered during a visual examination are:

- Cleanliness
- Ensure liquid deposits or debris are not trapped in cavities
- Ensure demountable seal faces are not scratched or distorted
- Ensure all vacuum surfaces are free from visible defects such as pitting, cracks and indentations
- Weld regions shall be free from scale, voids, blowholes, etc. and there shall be no evidence of inclusions
- A survey of the main dimensions.

Manufacturing operations (such as machining or grinding) following inspection of a particular area (e.g. a weld) shall not affect the inspected area. Otherwise the inspection shall be repeated after the manufacturing operation.

Note: Dye penetrant inspection must not be performed on any component surface that will be subject to vacuum.

<u>Inspections at Site</u>

After the delivery of a vacuum component to the SNS site, the following receiving inspections shall be performed:

- A general inspection to ensure that no deterioration or damage has occurred during transit
- A cleanliness inspection
- A confirmation leak test, as deemed necessary
- A check of the component documentation for completeness

Receiving inspections shall be carried out in a clean area.

<u>Testing at Manufacturer</u>

The testing to be performed in the manufacturing process shall be clearly stated in the appropriate procurement documentation.

Test conditions (pressure, temperature) should be as close as possible to the design conditions.

Leak tests on basic materials and purchased items should be requested on an appropriate level.

The final assembly shall be tested at the end of manufacture.

Following acceptance testing at the fabricator’s premises, the component or assembly shall be cleaned, inspected and packaged in accordance with this Handbook.

Testing at Site

After the delivery of a vacuum component to the SNS site, the following receiving tests shall be performed:

- A 100% leak test on all fabricated components such as beam pipes, enclosures, etc shall be performed to insure that no deterioration or damage has occurred during transit.
- A sample performance testing of commercially procured lots of items such as pumps, valves, gauges, etc shall be conducted.
- All receiving test data shall be recorded.

Testing during Installation

Leak testing of all vacuum boundary assemblies shall be performed during the installation of the associated items. Any construction/installation task that could affect the leak-tightness of an already tested element shall require a repeat of the test to be performed.

Leak Detection Methods

The test methods discussed below are the standard methods that should be used for all SNS components. However, other methods are acceptable, provided that they comply with the requirements of this handbook and achieve the required levels of leak detection sensitivity specified for a particular component.

Over-pressure: This method is useful when the equipment to be tested is filled with a gas used as the test medium. However, the test gas that flows out through leaks, always mixes with contaminants present in the air, which reduces sensitivity.

Gas sniffing probes: Helium shall be used to slightly pressurize the equipment to be tested. Then a sampling probe sniffs for leaks. The leak rate found depends on the gas detection sensitivity of the sampling probe. All traces of helium or halogens in the environment (chlorinates, cleaning agents, cigarette smoke etc.) will be detected by the detector, which may lead to errors in the leak detection.

Mass spectrometer: This is the most accurate over-pressure method. The helium content of the atmospheric air limits the sensitivity of the sampling probe. Helium emitted by a leak is sniffed with the surrounding atmosphere by a narrow long flexible tube.

The sampling tube should be as short as possible to reduce the response time to the mass spectrometer. The flow rate of the air-helium mixture from the entrance of the tube to the ion source determines the response time of the mass spectrometer but is limited by the pumping capacity.

Pressure rise method

In order to decide on which is the best method to be utilized to search for leaks, a pressure rise test should be carried out to evaluate the level of leak rate.

To distinguish real leaks from other different types of leak, the pressure rise method must be repeated at different pressures. A real leak results a pressure rise strictly proportional to time while virtual leaks result in a rapid pressure rise which tends to level off.

5.0 Standard Naming Convention

A standard naming convention shall be utilized for the accelerator vacuum system. The naming designation shall be used on drawings, schematics, computer software, project databases, equipment nametags, test procedures, and other sources of information. A vacuum system's element complete name is intended primarily for use on operator screens to communicate device and signal information that is most applicable to operators

The rationale for the vacuum naming convention format and syntax is provided in Appendix A. The official overall project naming convention is provided in the naming conventions document [12].

6.0 Quality Assurance Standards

All documentation associated with, or arising from, testing and inspections carried out during manufacture shall be included in the quality documentation package required by the QA Plan.[13]

For all SNS vacuum components, a dated test report giving details of the preparation, test results and including calibration certificates for the test equipment shall be included in the quality document package.

7.0 Applicable References

7.1 SNS Documents

Any conflict between information contained in this Handbook and other applicable SNS documents (see below) shall be resolved on a case - by - case basis.

[12] "Systems Requirements Document for Equipment, Device and Signal Naming", Document No. SNS 102000000-SR0001-R00., 5/20/00.
[13] "SNS Quality Assurance Plan ", #SNS 102040000QA0001, TBD

- SNS Parameters List, SNS 100000000-PL001-R02, 3/10/00
- SNS Design Requirements Documents, # TBD, TBD & TBD
- SNS Systems Requirements Documents, # TBD, TBD & TBD
- SNS Quality Assurance Plan, #SNS 102040000QA0001
- "Systems Requirements Document for Equipment, Device and Signal Naming", # SNS 102000000-SR0001-R00

7.2 Reference documents

Some international standards and recommendations useful for vacuum applications are as follows:

- TBD
- TBD
- TBD
- TBD

Appendix A
VACUUM DEVICE NAMING CONVENTION

$$\underbrace{\text{SSSS\_BBBB}}_{\text{System\_ Subsystem}}:\underbrace{\text{DDDD}}_{\text{Device}}\_\underbrace{\text{IIII}}_{\text{Instance}}.$$

Where:

System	SSSS = SRC, RFQ, MEBT, DTL, CCL, SCL, HEBT, RING, RTBT, LDmp, EDmp, IDmp
Subsystem	BBBB
Device Type	DDDD = TMP, CP, IP, RP, TCG, CCG, IG, BG, FV, FLV, RV, PIV, GV, SGV, VLV, MV, RGA, MAN,
Device Instance	IIII = the index number of item. i.e. location identifier and unit serial no., a, b, c etc. used if there are more than one device of the same type located in the same segment of the same system.

<u>System</u>

SRC	Ion Source
RFQ	RF Quadrupole
MEBT	Medium Energy Beam Transport
DTL	Drift Tube Linac
CCL	Coupled Cavity Linac
SCMB	Super Conducting Medium Beta Linac
SCHB	Super Conducting High Beta Linac
HEBT	High Energy Beam Transport
RING	Accumulator Storage Ring
RTBT	Ring to Target Beam Transport
LDmp	Linac Tune Beam Dump
IDmp	Ring Injection Beam Dump
EDmp	Ring Extraction Beam Dump

<u>Device</u>

TMP	Turbo Molecular Pump
CP	Cryogenic Pump
IP	Ion Pump
RP	Roughing Pump
TCG	Thermocouple Gauge
CCG	Cold Cathode Gauge
IG	Ion Gauge
BG	Bourdon Gauge
FV	Fast Closing Valve
FLV	Foreline Valve
RV	Roughing Valve
PIV	Pump Isolation Valve
GV	Gate Valve
SGV	Sector Gate Valve

VLV	Valve
MV	Manual Valve
VV	Vent Valve
RGA	Residual Gas Analyzer
MAN	Manifold

Table X: Vacuum Instance Numbering

Subproject	Instance Numbering	
	Most devices are associated with particular subsystems, and follow these general Guidelines:	
Front End	Examples from Front End	
	SRC_Vac:TMP_1	this Turbo Pump is located on the source and is unit #1
	SRC_Vac:VLV_1	this Valve is located on the source and is unit #1
	RFQ_Vac:CRYP_1b	this Cryo Pump is located on the RFQ module #1 and is the second unit on that module
	MEBT_Vac:IP_7	this Ion Pump is located on the MEBT and is the seventh unit.
Linac	Examples from Warm Linac:	
	DTL_Vac:IG_2a	this Ion Gauge is located on DTL tank #2.
	CCL_Vac:IP_4b	this Ion Pump is located on CCL module #4 and is the second unit on that module.
	Examples from Superconducting Linac:	
	SCMB_Vac:IG_3	this Ion Gauge is located on the 3^{rd} medium beta cryomodule.
	SCHB_Vac:VLV_15b	this Valve is located on the 15^{th} high beta cryomodule and is the second unit on that module
	SCHB_Vac:IP_WM21c	this Ion Pump is located on the 21^{st} warm section and is the third unit on that section.
Ring	Examples from HEBT:	
	HEBT_Vac:SGV_10	this sector valve is located, after quadruple QH10
	HEBT_Vac:IP_10	this Ion Pump is located, after quadruple QH10
	Examples from RING:	
	RING_Vac:IG_A4	this Ion Gauge is located, after quadruple QHA4, in the A superperiod
	RING_Vac:IP_C11b	this Ion Pump is the 2^{nd} ion pump after QVC11 in C superperiod
	Examples from RTBT:	
	RTBT_Vac:IG_02	this Ion Gauge is located, after quadruple QH2, in RTBT